WORKING PLAN

KHUTZEYMATEEN VALLEY GRIZZLY BEAR STUDY

Ministry of
Environment
Victoria, B.C.

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Khutzeymateen Valley Grizzly Bear Study

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A Cooperative Project Between the Ministries of Environment and Forests

Wildlife Branch
Ministry of Environment
Victoria, B.C.

Fish and Wildlife
Ministry of Environment
Smithers, B.C.

Integrated Resources Branch
Ministry of Forests
Victoria, B.C.

Research Branch
Ministry of Forests
Victoria, B.C.

Prince Rupert Forest Region
Ministry of Forests
Smithers, B.C.

North Coast Forest District
Ministry of Forests
Prince Rupert, B.C.

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The Khutzeymateen Valley Grizzly Bear Study is a component of the Khutzeymateen Project, a 3- year cooperative study designed to provide the information necessary to develop a plan for the future use of the Khutzeymateen watershed in north coastal British Columbia. This working plan describes the environmental setting, objectives, methods, and proposed approaches to assessing the potential impacts of logging and silviculture on grizzly bears (*Ursus arctos*) and their habitat.

The Khutzeymateen has been the focus of a major resource allocation conflict since the early 1970's. Unlike other wilderness issues in the province, the Khutzeymateen controversy is primarily focused on only two major values: the valley's 25-40 grizzly bears and its timber. In 1972, a team of scientists under the auspices of the United Nations International Biological Program proposed the establishment of an Ecological Reserve in the Khutzeymateen watershed to protect grizzly bears and their habitat. The provincial Ministry of Recreation and Conservation (now Environment) recognized the high wildlife and fisheries values and has strongly supported the reserve proposal since that time. The Ministry of Forests opposed any form of land status that prevented logging development. The controversy continued without resolution throughout the late 1970's and into the 1980's. Karanka (1986) provides a more detailed summary of the history of the conflict.

The Khutzeymateen is the core of a grizzly bear kill-free area established in 1984 to help ensure population viability into the future (van Drimmelen 1985). There are no parks, reserves, sanctuaries, or other special status lands specifically protected for grizzly bears in Canada. Only two small Provincial Park Reserves on the mainland coast of B.C. (Fjiordlands and the Gitnadoix) contain grizzly bears (McCrory and Herrero 1987). Environmentalists believe the Khutzeymateen presents an excellent opportunity for creating a grizzly bear reserve because the undeveloped watershed could form a wilderness habitat core for the kill-free area (McCrory and Mallam 1988). Various land tenures have been proposed, ranging from Ecological Reserve to Wildlife Management Area.

The Khutzeymateen is being promoted as a wilderness tourism destination. Opportunities for float trips, sports fishing, nature study, and bear viewing are offered. Three nature tour operators brought their clients to the watershed during 1989, providing an opportunity to examine potential behavioural responses by collared grizzlies to this type of activity.

The Khutzeymateen also has significant timber values. An inter-agency planning team was set up in 1984 to prepare an integrated management plan for the watershed. It concluded that with full environmental constraints to protect critical fisheries and grizzly bear habitat and partial constraints to protect other important areas (Conceptual Plan A), there would be 1.25 million m^3 available for conventional harvesting (Dow 1984). The team also concluded that another 250 000 to 500 000 m^3 of timber is accessible by helicopter. The operable forest land base available for harvesting covers approximately 5400 ha within the watershed and the adjacent Larch and Cedar Creek drainages. Operable volumes in the Khutzeymateen have been estimated by the B.C. Forest Service to represent 3-4% of the operable mature timber accessible by current practices in the North Coast Timber Supply Area. Proponents of the grizzly bear reserve dispute these estimates, and suggest there are only 319 000 m^3 of operable timber available (Hammond 1988).

In 1986, the Provincial Cabinet included the Khutzeymateen on the list of wilderness areas to be reviewed by the Wilderness Advisory Committee (WAC). The WAC was established:

1. to investigate and make recommendations about the existing supply and demand for wilderness areas in British Columbia,

2. to provide recommendations on specific land use allocations for 16 wilderness areas, and

3. to examine the possible opportunities for making appropriate adjustments in the boundaries of seven provincial parks (Hansard 29 November 1985).

The WAC reviewed the interests of various resource user groups and made the following recommendations on the future status of the Khutzeymateen:

1. Logging should be permitted, provided that sufficient field studies acceptable to the Wildlife Branch of the Ministry of Environment are undertaken and their conclusions are incorporated into the logging plan. The plan should be jointly approved by the Ministry of Forests and Ministry of Environment.

2. The forest company should assume 50% of the cost of whatever wildlife studies the Wildlife Branch judges to be needed to prepare a logging plan.

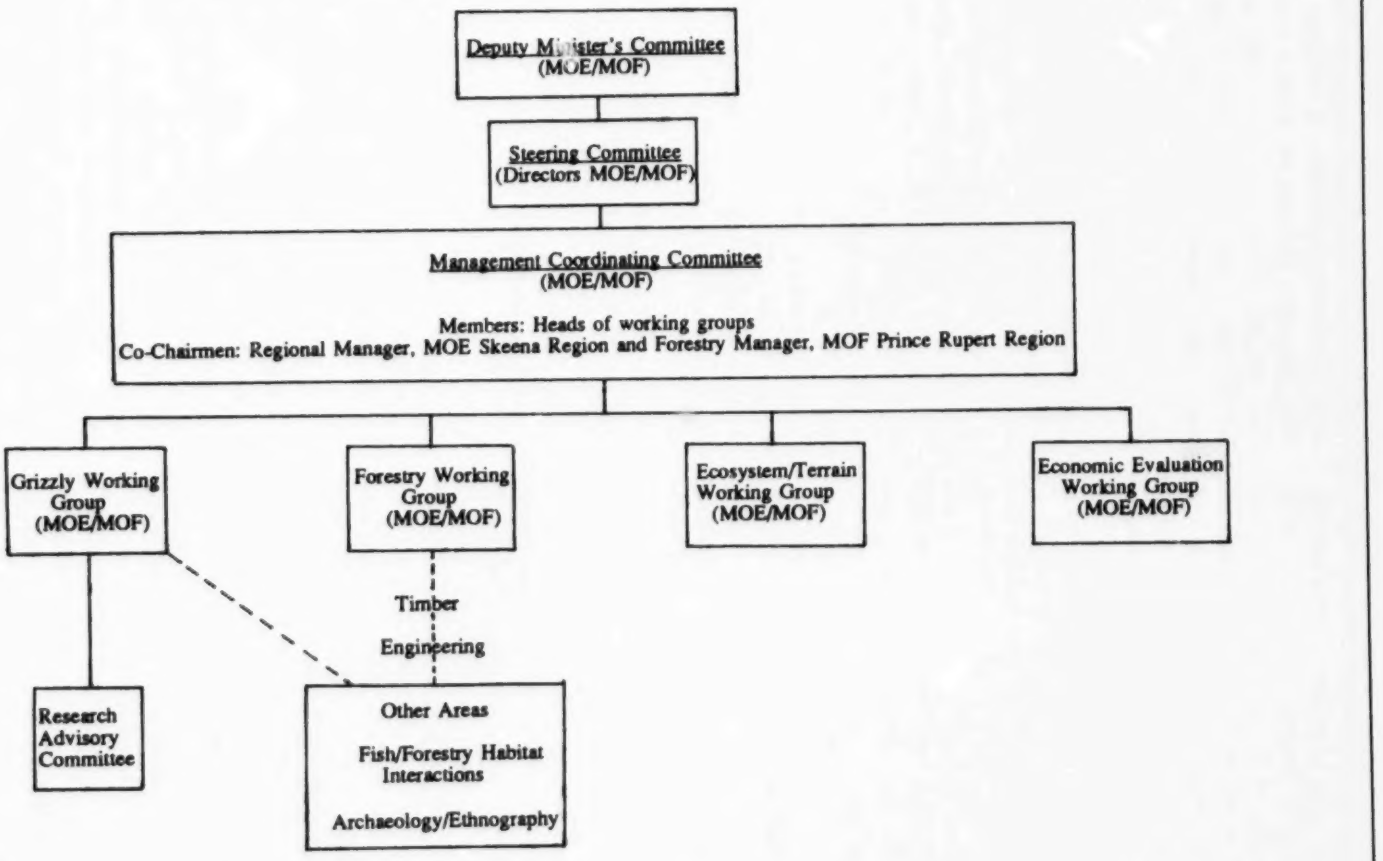
3. The logging plan should include a provision for the Ministry of Environment to monitor the effects of the approved logging plan on bears and for the Ministry of Forests to adjust cutting plans, if necessary.

Based on these recommendations, the Ministries of Forests and Environment formally agreed in June 1988 to undertake a cooperative study to assess the potential impacts of logging in the Khutzeymateen on grizzly bears and their habitat. A Memorandum of Agreement (MOA), signed by the two Ministries, details the purpose, administration, budget and duration of this study. Contrary to the WAC recommendation, a forest company is not contributing funds to the study. In addition, the MOA states that "if these assessments indicate that the impacts of logging on grizzly bears and grizzly bear habitat are unacceptable, then logging will be reconsidered".

The study mandate recommended by the WAC focuses on determining how forest and grizzly bear management can be integrated in the Khutzeymateen. Although the MOA appears to embrace the WAC suggestions, it also implies that if impacts on grizzlies are determined to be "unacceptable", preservation of the watershed will be considered. However, neither the WAC nor the MOA addresses the broader issue of establishing a coastal wilderness reserve for grizzly bears. The original terms of reference of the study were far more narrow: to predict how the grizzly bears using the Khutzeymateen will be affected by logging development and to determine if these effects are acceptable. In 1989, a fundamental change in the scope of the overall project was adopted by the Project Management Coordinating Committee. The potential impacts of logging in the Khutzeymateen will now be assessed in the context of long-term management objectives for grizzly bears and timber resources in north coastal British Columbia. Despite this change, the Project terms of reference are restricted to grizzly bears and forest development; issues such as wilderness tourism, scientific benchmarks and wilderness preservation are not addressed.

Committees and working groups have been organized to oversee the Khutzeymateen Project (Figure 1). The Steering Committee will ensure that each component proceeds, including: a timber inventory, a road engineering study, the classification and mapping of ecosystems and terrain, a grizzly bear study, and an economic evaluation of forest development. Other important components, including tourism potential, fisheries values, and archaeological/ethnographic resources will be considered, but are not part of the project's mandate. The results of the Khutzeymateen Project will be used to develop several future land use scenarios for the watershed; each land use scenario will be supported by relevant technical data. The timber resources of the Khutzeymateen will remain unallocated for the duration of the project (i.e., 1989-1992).

Figure 1. Organizational Structure - Khutzeymateen Project



The Khutzeymateen Valley Grizzly Bear Study will rely heavily on information obtained by the Coastal Grizzly Project. Begun in 1982, and jointly funded by the Ministries of Forests and Environment, this project was designed to determine the effects of logging and silviculture on grizzly bears throughout coastal B.C. (Archibald and Hamilton 1985). Although not complete, this research provides an extensive data base against which results from the Khutzeymateen can be compared. To facilitate this comparison, several field data collection and analysis methods developed in the Kimsquit and other coastal watersheds will be applied in the Khutzeymateen. Results from the Coastal Grizzly Project regarding the impacts of logging (Hamilton 1988) will help predict the potential impacts of development in the Khutzeymateen. Data will also be compared to information collected in southeast Alaska. Dr. J. Schoen (pers. comm.) has suggested the study team take advantage of these data (since 1981 the Alaskan researchers have collected over 4000 relocations of over 100 radio-collared grizzly bears from Admiralty and Chichagof islands).

Although details have not been finalized, the Forestry Working Group will propose several economically viable land use scenarios. Under the direction of the Grizzly Working Group and with the advice of an external Research Advisory Group, the Khutzeymateen Valley Grizzly Bear Study will investigate grizzly bear ecology in the valley and predict the short-, medium-, and long- term effects of proposed land use scenarios on resident and transient grizzly bears and their habitats. The potential impacts of road construction, road use, timber harvest, silvicultural activity, and man-bear interactions will be examined. Impacts of proposed land use scenarios on grizzly bear habitat use, habitat values, movements, population productivity, and population viability will be predicted. A time schedule for year 1 activities (1989/1990) is given in Appendix A, and proposed study documents are listed in Appendix B.

In December 1989, a joint MOE and MOF working group was formed to develop a formal definition of "acceptable" impacts. This group also has the responsibility of creating a model that integrates the various project components. An overall flow chart of information by components and a description of how these components interact will be produced.

OBJECTIVES

The objectives of the Khutzeymateen Valley Grizzly Bear Study are:

1. to test current concepts of seasonal habitat use and selection by coastal grizzly bears and, if necessary, to develop a revised conceptual model applicable to the Khutzeymateen ecosystems;

2. to identify, map, and determine the availability of habitat units and assess their relative importance to grizzly bears using the Khutzeymateen;

3. to identify and quantify the available resources within these habitat units (e.g., food, cover) and assess their relative importance to grizzly bears using the Khutzeymateen;

4. to estimate the population density of grizzly bears resident in the Khutzeymateen, and estimate the total number of bears using the watershed;

5. to predict the impacts of proposed land use scenarios for the Khutzeymateen on grizzly bears and their habitat.

Objectives will be met through habitat classification and mapping, intensive monitoring of radio-collared grizzly bears, and application of information collected during the Coastal Grizzly Project. Habitat and population impacts of development will be projected with computer modelling (forest and bear population simulations) and resource map overlays using a Geographic Information System.

STUDY AREA

The Khutzeymateen Valley is located 45 km northeast of Prince Rupert at the head of Khutzeymateen Inlet. The watershed is approximately 390 km² in area. The study area includes two drainages entering Khutzeymateen Inlet from the south: Larch and Cedar creeks (Figure 2).

The climate of the study area is wet, humid, mild, and oceanic (Banner and Yole 1986). As elevations increase, temperatures decrease and both the total precipitation and snowfall increase. Information summarized for five weather stations by Banner and Yole (1986) indicate that temperatures vary little throughout the year; the mean annual temperature is 7 degrees C; the mean temperature of the warmest month is 16.1 degrees C, while the mean of the coldest month is -3.1 degrees C. Precipitation is heavy: mean annual precipitation is 304 cm and mean annual snowfall is 356 cm (approximately 12% of the annual precipitation). Although winter conditions are not usually extreme, outflow winds can lead to freezing of Khutzeymateen Inlet; there was at least 30 cm of ice for over 20 km of the inlet on 9 March 1989.

Located in the Western Kitimat Ranges of the Coast Mountains, the topography of the Khutzeymateen, is rugged. Elevations range from sea level to over 2100 m. Several active glaciers occur in the drainage. The terrain in the watershed was mapped by Baender (1976) at 1:50 000. Major units include: a large, active estuary; level fluvial areas (floodplain); some upslope units that are extremely shallow to bedrock; numerous avalanche chutes; organic bogs; and several fans. Soils are typically Humo-Ferric Podzols and Ferro-Humic Podzols in midslope positions. However, Typic Folisols are common on shallow-to-bedrock sites.

Three biogeoclimatic zones are represented in the watershed including: the Coastal Western Hemlock (CWHvm subzone), the Mountain Hemlock (MHa subzone), and the Alpine Tundra zones. The Very Wet Maritime (CWHvm) subzone was formerly called the CWHi subzone; draft ecosystem classifications for the CWHi are available (e.g., Yole et al. 1982, Banner and Yole 1986). The zonal plant association (Pojar et al. 1987) is *Tsuga heterophylla* (western hemlock[1]) - *Abies amabilis* (amabilis fir) - *Thuja plicata* (western redcedar) - *Vaccinium* spp. (blueberry, huckleberry species) - *Blechnum spicant* (deer fern) - *Rhytidiadelphus loreus* (lanky moss) - *Hylocomium splendens* (step moss). Seral associations on the Khutzeymateen floodplain appear typical of those further south with *Alnus rubra* (red alder) and *Populus balsamifera* ssp. *trichocarpa* (black cottonwood) dominating (see Banner 1985). Considerable field sampling on logged sites has been completed in the Khutzeymateen Inlet as part of an investigation of the effects of porcupines on forest re-growth (Sullivan et al. 1986).

The fisheries resources of the Khutzeymateen have been estimated to have a commercial value as high as $5 million annually (Janz 1984). Net wholesale contribution to the economy is $1.58 million per annum (Kremer 1985). These values apply to the commercial fishery only; no estimates have been made for the economic activity associated with sport fishing in the watershed.

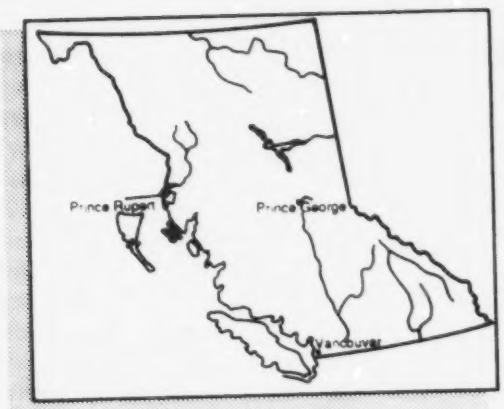
In 1986, a salmon habitat inventory project was undertaken by the Department of Fisheries and Oceans (Karanka 1986). Its objectives were:

1. to assess salmonid habitat throughout the watershed,

2. to assess coho juvenile habitat suitability, particularly in the side channels and tributaries, and

3. to evaluate pre-logging channel stability.

Karanka (1986) concluded that the Khutzeymateen is the second most important salmon stream in the region bounded by the Nass and Skeena valleys to the north and south, the Kitsumkalun-Tseax valley to the east, and the Pacific Ocean to the west. The



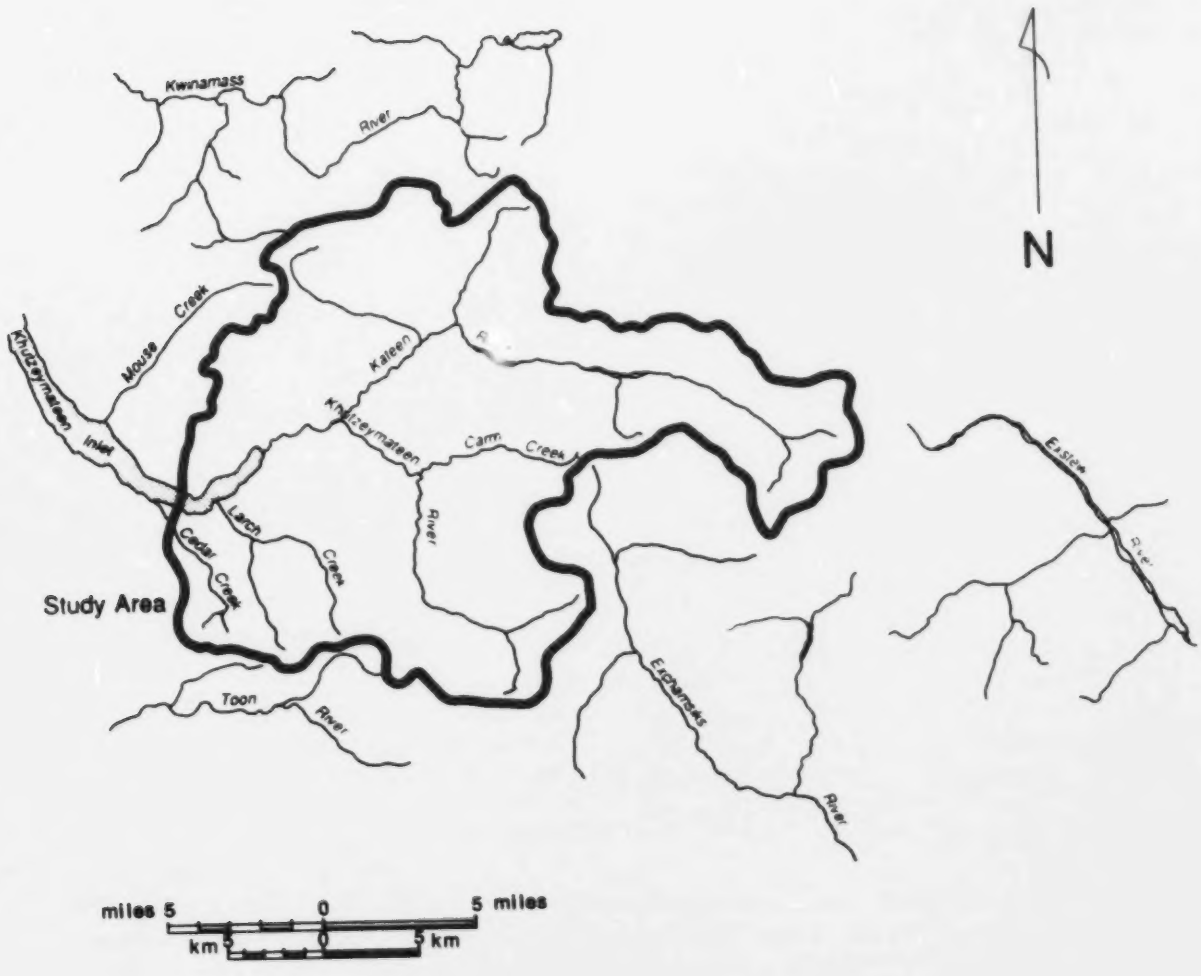


Figure 2. Location of study area.

watershed has important runs of chinook, chum, coho, and pink salmon; steelhead are also present. The median escapement estimates are (with highest estimate in brackets): 750 chinooks (3500), 3500 chum (20 000), 1350 coho (10 000), and 10 000 pinks (80 000) (Karanka 1986). The Khutzeymateen system includes over 55 km of channels with slopes <5%, with nearly 75% (40 km) of that known to be accessible to at least one species of salmon (Karanka 1986). Karanka (1986) also provides a detailed summary of salmonid habitat values, coho juvenile habitat suitability, and channel stability in the Khutzeymateen watershed.

In addition to a population of grizzly bears, many other wildlife species occur in the Khutzeymateen watershed. The large estuary is a very important staging area for migratory waterfowl. Other wildlife species present include Bald Eagles (*Haliaeetus leucocephalus*[2]), Golden Eagles (*Aquila chrysaetos*), black bears (*Ursus americanus*), wolves (*Canis lupus*), mountain goats (*Oreamnos americanus*), wolverines (*Gulo gulo*), porcupines (*Erethizon dorsatum*), red squirrels (*Tamiasciurus hudsonicus*), and harbour seals (*Phoca vitulina*). The presence of at least one moose (*Alces alces*) was verified in September 1986 (Hamilton unpubl. data).

There are three small Indian reserves in the Khutzeymateen. Heritage resources of the watershed were examined during 1989 by the Archaeology and Outdoor Recreation Branch of the Ministry of Municipal Affairs, Recreation, and Culture in cooperation with the Port Simpson Indian Band (Eldridge 1989).

Stumps with spring board holes occur throughout the lower reaches of the Khutzeymateen River. However, the only significant logging in the watershed occurred in 1950, when a small stand of timber next to the estuary was removed by Columbia Cellulose Ltd. (Karanka 1986). Considerable volumes were removed from elsewhere in the Inlet first by various operators using "A" frames during the 1950's and 1960's (Sullivan et al. 1986) and later with helicopters by Silver Grizzly Ltd. under a major Timber Sale Licence.

FIELD METHODS

Habitat Inventory - Classification and Mapping

Habitat types in the Khutzeymateen study area will be classified using the Biogeoclimatic Ecosystem Classification system (Pojar et al. 1987). General sampling methods will follow Walmsley et al. (1980); data entry procedures, Sondheim et al. (1983); and data processing system, Meidinger et al. (1987). Distinct habitat units will be identified by incorporating seral communities and disclimaxes (e.g., avalanche chutes) into the existing climax-based classification for the CWHvm (Yole et al. 1982). Classification and mapping will follow the Kimsquit example (Banner et al. 1986). Habitat maps will be at two scales: 1:10 000 for the operable area (50% polygon visitation) and 1:20 000 for the entire study area (including operable area - 10% polygon visitation). The operable area, defined by the Forestry Working Group, covers the portion of the study area that contains the economically accessible timber.

Banner et al. (1986) and Clement (1984) identified 15 climax forest and 3 subalpine ecosystem associations, and 6 non-forested disclimaxes in the Kimsquit study area; 110 different habitat types were mapped. Hamilton (1987) combined these types into 14 Bear Habitat Units (BHUs) (Table 1) using the following criteria: similarity in age, structure, species composition, elevational distribution, and landform/soil type; and, similarity in bear food, security cover, and thermal cover values. Observed movement patterns and seasonal habitat use data were used to help determine these values. If grizzly bears did not exhibit different types or timing of use, related habitat types were combined. The interpretive classification was also used to structure potential forest management prescriptions (cf. treatment units, Klinka et al. 1980). Ideally, a similar classification will be developed for the Khutzeymateen.

Each proposed land use scenario developed by the Forestry Working Group will have a unique cutblock layout (i.e., location and size).

Table 1. Coastal grizzly Bear Habitat Units (BHUs) in the Kimsquit River, B.C.

Name	Acronym	Description
Non-vegetated	NV	includes high elevation rock and ice, river sandbars, roads, and 1-2 year old cutovers
Estuary	EY	beach fringe, backshore and intertidal zones near the river mouth
Avalanche chute	AC	disclimax snow avalanche tracks and valley sideslope early seral habitat types
Mountain hemlock	MH	all forested habitats in the Mountain Hemlock Zone
Subalpine parkland	SA	mostly high elevation krummholz and parkland types, includes some other alpine habitats
Dry shore pine	PL	very dry, low elevation rocky knolls dominated by shore pine
Sedge fens	SF	includes low and high elevation sedge-dominated bogs, fens, and other non-forested wetlands
Skunk cabbage swamps	SS*	various overstory species, organic soils, high water table, and high cover of skunk cabbage
Sidehill and bench climax and old-growth forests	SO*	a 'catch-all' unit which includes all mesic to subhygric coniferous forest types not on the river floodplain
Subxeric forests	SM*	drier forests commonly found on the lower elevation side slopes, differentiated from the SO by the lack of amabilis fir
Floodplain climax and old-growth forests	FO*	Sitka spruce and other valley bottom coniferous forests with alluvial soils; may occur on creek fans
Floodplain seral forests	FF	equivalent site characteristics to the FO but dominated by pole sapling to mature climax black cottonwood or red alder forests
Floodplain seral non-forest	FS	early seral pioneer herb and shrub habitats on recently flooded river sandbars
Logged	LG	all cutovers between the ages of 2 and 5 years; could also be described as seral types of forested BHUs if site disturbance not excessive

*Commercial forest

Of equal importance, each scenario will have a unique schedule of road construction, felling, yarding, and expected silvicultural activity. To predict the long-term impacts of logging on habitat capability adequately, the expected future (post-logging) condition of habitats will be simulated. A simple simulator will be developed for the Khutzeymateen with the ability to track bear habitat value through time.

Modelling expected future condition of forests after logging has a long history, culminating in the myriad of complex and powerful computer-based forest simulators in use today, e.g., FORCYTE (Kimmins 1985). However, most forest simulators deal only with conifer re-growth (i.e., overstory). Accurate habitat simulation will depend on a post-logging (secondary succession) classification of seral associations (i.e., overstory and understory). Since only minimal logging has occurred in the Khutzeymateen valley, data from Khutzeymateen Inlet (Sullivan et al. 1986) may be used; if possible, additional data will be collected in other logged areas in the vicinity (e.g., Kwinimass). Accurate simulation will also depend on accurate mapping, with sufficient ground truthing to verify photo-assigned labels.

If the interpretive classifications for grizzly bears and forest management are linked in a simulation of timber harvesting with a model of overstory and understory re-growth, direct assessment of proposed silvicultural treatments will be possible. For example, if a floodplain BHU with high bear food value also has a high potential for brush competition, future habitat value would depend on whether herbicide use was forecast.

Capture and Handling

Trapping will be conducted in the Khutzeymateen watershed during May 1989. Thirty-five to forty trap sites will be established in spring habitats in the Khutzeymateen, Kateen, Larch, and Cedar drainages. Grizzly bears will be captured in Aldrich leg hold snares set in baited cubbies (Pearson 1976, Nagy and Russell 1978, Russell et al. 1979, Nagy et al. 1989). In addition, snares will be set on trails leading to trap sites when bear activity is evident. Trap transmitters will be attached to snares set in cubbies to allow for helicopter monitoring of the trap line (Nolan et al. 1984). Daily visual checks will be made at sites with trail sets. Some of the trap transmitter devices will be equipped with digital clocks so that time of capture can be determined (Hawley et al 1985). A ground-monitored trapline will be established in late summer/early fall when bears concentrate on salmon spawning areas (Archibald and Hamilton 1985, Hamilton 1987). Sites will not be baited; snares will be set along trails adjacent to the spawning channels.

Grizzly bears will be immobilized with M99 (etorphine hydrochloride - Cyanamid Canada Ltd.) at approximate dosages of 1 mg per 50 kg body weight (Hebert et al. 1980, Archibald and Hamilton 1985, Nagy et al. 1989). M99 was chosen as the immobilizing drug for several reasons (Archibald and Hamilton 1985):

1. Lower volumes are required than other drugs, thus lessening tissue damage and allowing for better delivery trajectory.

2. Bears have a wide range in tolerance to M99 allowing for considerable error in weight estimation.

3. M99 has a short induction time and thus reduces the potential for heat or cold stress on animals.

4. The antagonist, M50-50 (diprenorphine), allows control of recovery of immobilized bears. Using M50-50 minimizes the duration of immobilization, reducing the potential for intra- and inter-specific predation of immobilized bears by free-ranging animals.

5. M99 produces consistent patterns of immobilization, maximizing researcher safety.

The estimated weight of each captured bear, volume of M99 used, induction time and various other aspects of the immobilization procedure will be recorded (Appendix C). M50-50 will be administered either intramuscularly, or as a combined intramuscular (50% of dose) and intravenous injection (Hebert et al. 1980). Behavioural responses of bears will be recorded during the period of induction. Immobilized bears will be laid in a prone position with the anterior body weight supported by the front legs to reduce pressure on the chest and allow free air passage. The eyes will be covered to prevent desiccation and damage. Respiration rate (rrpm), heart rate (ppm), and rectal temperature (°C) will be recorded at 10-15 minute intervals during immobilization.

The following measurements of physical characteristics and condition will be recorded for each bear captured: body weight (kg), zygomatic width (cm), skull length (cm), total body length (cm), tail length (cm), shoulder height (cm), neck girth (cm), heart girth (cm), abdominal girth (cm), canine length (cm), canine width (cm), span of upper canines (cm), length and width of front and hind foot (cm), baculum length (cm), nipple length (cm), tooth wear, vulva condition, evidence of lactation, evidence of nursing, pelage color, and pelage condition (Appendix C). Bears will be weighed by suspending them in a cargo net from a dial-face scale (±5 kg precision) attached to the cargo hook of a hovering helicopter or from a tripod (Nagy et al. 1983*a*,*b*; Nagy et al. in prep.). Neck, heart, and abdominal girth measurements will be made with a steel tape pulled to uniform tension using a 1-kg spring scale with the animal laid prone.

A premolar tooth will be extracted and sectioned to determine age by counting cementum annuli (Pearson 1975, Stirling et al. 1976). Hair samples will be collected from the dorsal body region and frozen for possible use in DNA fingerprinting (E. Vyse and M. Cronin pers. comm.). Bears will be examined for external parasites; specimens will be collected when found and stored in 10% formalin. Faeces will be collected when available at each capture site and then dried or frozen. Blood samples will be collected for potential DNA analyses (E. Vyse and M. Cronin pers. comm.). All individuals will be tattooed in the lip, ear, and groin for permanent identification.

Selected adult grizzly bears will be fitted with fixed-diameter radio collars (Telonics Ltd., Mesa, Arizona). A section of fire hose will be inserted in the collar to ensure that they drop off either during the study or shortly after field work is completed. Radio collars are equipped with 5-second delay, pulse/reset devices so that general activity (moving, resting) can be inferred during aerial and ground monitoring. Battery life for the collars is estimated at 30 months. Radio collars are colour-coded to allow visual identification of individuals.

Optimally, 6 adult female and 4 adult male grizzly bears will be equipped with radio collars. A maximum of 8 bears will be collared during the spring capture period. A spring capture session will help ensure that most bears collared are resident to the watershed; bears are less likely to have moved long distances from their dens in the early spring. By focusing on adult females, the ability to track and monitor the habitat use of residents is maximized. Female grizzly bears in the Kimsquit study had smaller home ranges and moved less, providing far more accurate telemetry and habitat use data than males (Hamilton et al. 1986). Two adult grizzly bears will be collared during the late summer-fall period along salmon streams in an effort to select non-resident animals. Monitoring non-residents will help determine the extent of the area from which bears move into the Khutzeymateen watershed during the salmon runs. At present, the project budget does not allow a larger sample size to improve the reliability of these data. Trapping without bait periodically throughout the study will maintain the collared sample at ten individuals.

Monitoring

Aerial tracking surveys will be conducted weekly after the first captured bears are collared and until denning in November or December (Nagy et al. 1983*a*,*b*; Archibald and

Hamilton 1985). A Cessna 180 fixed-wing aircraft equipped with a directional H-antenna mounted on each wing at 30° to the horizon will be used to locate study bears. Surveys will be flown between 500 and 3000 m altitude until a signal is received. The location of an animal will be established by maximum signal strength or visual sighting following low level searching. All locations and areas of associated uncertainty will be recorded on 1:20 000-scale topographic maps produced by the Terrain Resource Information Management (TRIM) initiative (Balser 1987). Universal Transverse Mercator (UTM) coordinates (±50 m) and elevations for all aerial locations will be determined and recorded. Subsequently, these data will be analyzed to describe changes in range size, patterns of movement, and activity centres; fidelity to seasonal and annual home ranges; and changes in elevational distribution between sex classes within and among seasons.

Regular, accurate ground telemetry is critical to the study design. Telemetry reliability will be limited in the Khutzeymateen because of the dense vegetation, high rainfall, rugged terrain and restricted access (jet boat, hiking). To minimize these influences, ground monitoring will be conducted using a modification of a system described by Hamilton and Archibald (1986). After initial scanning and assessment of signal strength, several bearings will be taken from pre-established locations along the river. Bearings will be entered into a portable computer for use in a program that calculates the best estimate of the bear's location in UTM coordinates (based on the intersection of several bearings).

Sites for subsequent ground visitation will be selected using the following criteria:

1. location polygon <1 ha in area (Hamilton and Archibald 1986),

2. signal strength and direction confirm actual animal location rather than signal bounce, and,

3. the location polygon is within 4 km hiking distance of the river corridor or the mouth of Larch and Cedar creeks.

Tests will be conducted to determine ground telemetry accuracy and precision. Results of these tests will be used to refine the ground visitation criteria. Ground telemetry effort will also depend on the capture success and activity centre location of the study animals. Extended fly camping may be required to monitor some of the study animals.

Home ranges will be determined using modified minimum convex polygon (MCP) (Harestad 1981) and harmonic mean measures of home range size (Dixon and Chapman 1980, Hamilton 1987). Verified aerial and ground location data will be used to determine home range size, potential human avoidance, and identify seasonal and annual activity centres. Ideally, a minimum of 20 verified locations per bear per season will be recorded (seasonal location data from the 3 years will be combined).

Habitat Use

Hamilton (1987) described eight seasons of grizzly bear activity based on food plant phenology, the availability of preferred foods, and major shifts in use of Bear Habitat Units by collared grizzly bears (Table 2). The relative food value of Bear Habitat Units in the Kimsquit was assessed during each season. Although movements and feeding behaviour of two intensively monitored adult female grizzly bears were generally not correlated with forage at the finer (habitat type) level of the Kimsquit classification, they were at the BHU level. It was also shown that grizzly bears in the Kimsquit responded to the availability of security and thermal cover (Bryden and Hamilton in prep.); bedding habitats had significantly denser cover than was generally available.

Monitoring habitat use will follow an adaptation of the system developed in the Kimsquit (Hamilton 1987). Site investigations will be conducted to determine which habitat units are used, and what activities grizzly bears exhibit in them. Bear locations accurate enough to ensure that evidence of bear activity could be found (feeding, bedding, marking, scats) will be plotted onto 1:10 000-scale air photos and visited as soon as possible. Care will be taken not to displace collared animals from preferred habitats. Hamilton and Archibald (1986) found approximately 30% of sites visited provided useful information. Other grizzly bear activity and habitat use data will be collected as encountered during the site investigation process. These data will be of lower quality because they will most often lack information on individuals responsible and date of use. Patterns of use from this data set will be compared to collared animals.

The floristics, physiognomy, vigour, and other vegetative characteristics of the used habitats will be recorded using standard collection methods (Walmsley et al. 1980). The rank order of the amount and the phenological stage of each food species consumed will be recorded at verified feeding sites (Hamilton and Archibald 1986), along with an index of berry abundance. Site and bear activity characteristics will be recorded on a standard data form developed in the Kimsquit (Appendix D). A separate data collection form will be used for mark trees (Appendix E).

In addition to data collected at site investigations, diet will be examined using scat analyses procedures described by Mealey (1975). Known bear, known date scats will be collected opportunistically and either air dried or frozen. Faeces will be washed through sieves of 250- m, 500- m, and 4-mm mesh size. Fragments collected on the sieves will be recombined and a 10%, by volume, sample taken for analysis. The sample will be floated in a tray of water, sorted, and the percent occurrence by volume will be recorded using the following classes (Servheen 1983): 0-1, 1-5, 5-25, 25-50, 50-75, 75-95, and 95-100. The diet composition data will be summarized by food item and major food group (berries, roots, herbaceous, etc.) for each season of activity. If applicable, correction factors developed by Hewitt and Robbins (in press) will be calculated to improve the reliability of diet importance values.

Because of limits on ground access and telemetry reliability, special measures will be taken to ensure that all available habitats are sampled for bear use and to determine the resources available within them. Food availability and phenology data will be collected during the habitat mapping program. In addition, a data collection system involving regular visitation to representative ecosystem units will be developed. This system will ensure that heavily used habitats are put in the context of all habitats available, and help avoid misinterpretation of study results such as described by McLellan (1986). Polygons of representative ecosystem units (within a reasonably accessible test area) will be selected randomly for evaluation. Ecosystem units will be sampled in proportion to their occurrence within this area. The amount of effort devoted to this type of sampling will depend on the preliminary assessment of ground telemetry reliability and access within collared bear home ranges. The ground telemetry sample in the Kimsquit was biased to the floodplain; telemetry reliability decreased with increasing elevation (Hamilton et al. 1986). During each weekly or bi-weekly visit the field crew will walk through the polygons to assess the type and amount of grizzly bear activity and collect food plant phenology and berry abundance data. If aerial telemetry indicates that portions of the collared bear home ranges are not being sampled by ground telemetry, efforts may be directed to the unsampled area(s).

Hypotheses - Habitat Use

The following hypotheses have been formulated to ensure that data collection is directed towards meeting the primary study objective, predicting the impacts of forest development scenarios:

Table 2. Seasons of grizzly bear activity in the Kimsquit River, B.C.

Season number	Start	Definition	Season length (days)				Average season length (days)
			1982	1983	1984	1985	
1	Early April	Emergence to valley floor leaf flush	-	6	4	6	5
2	Mid-April	Leaf flush to avalanche chute green-up	-	24	44	35	34
3	Late May	Avalanche chute green-up to berry production	45	31	34	71	45
4	Late June	Berry production, no salmon	27	42	36	27	33
5	Late July	Berries and salmon	35	35	40	36	37
6	Late August	Salmon, no berries	45	45	33	29	38
7	Mid-October	Post-salmon	16	8	17	-	14
8	Early November	Denning	166	160	141	-	156

1. The floodplain climax and old-growth forest (FO) and skunk cabbage swamp (SS) bear habitat units (BHUs) are used in proportion to their occurrence within-home-range availability ($p \leq .01$) by radio-collared grizzly bears. Both of these units are commercial forest. If these BHUs are used disproportionately than indicated by their availability within the (multi-year seasonal and annual) home ranges, this will be considered evidence for active selection by collared bears. While active selection may simply indicate preference rather than critical dependence, such data are essential to the impact assessment process.

2. Bedding, marking, and travel activity in the sidehill and bench climax and old-growth forest (SO) by radio-collared grizzly bears occurs evenly throughout habitat patches of this type. That is, there is no association between these activities in the SO and the proximity to other bear habitat units. This hypothesis may also be tested for other commercial forest BHUs. If activities do not occur evenly throughout habitat patches, this will also be considered evidence for active selection of habitat and resources by patch (rather than type) — evidence that would not come to light in traditional use/availability comparisons.

3. The number of seasons of use of the floodplain climax and old-growth forest BHU by radio-collared grizzly bears is not significantly different ($p \leq .01$) than the number of seasons of use for other commercially forested BHUs (where "use" is defined by >5 bear locations per BHU per season). Significantly more use of the FO will be used as evidence of grizzly bear habitat value, particularly if used in the early or late seasons when fewer alternates are available.

4. There are no significant differences ($p \leq .01$) among the food value and security and thermal cover ranks among the commercial forested bear habitat units. Further, there is no correlation between use by collared grizzly bears and the value ranks for these BHUs. Evidence to the contrary will indicate higher relative habitat value.

5. Collared grizzly bears will use elevational strata in proportion to their availability. Tests will be made on a home range basis for the active seasons, using 100-m bands. A rejection of this hypothesis ($p \leq .01$) will be an indication of active selection for certain elevations. This information will be compared to the elevational distribution of cutblock layouts to assess the degree of overlap between grizzly bears and proposed development.

The seasonal use ranks for each BHU in the Kimsquit (Table 3) serve as a basis for comparing similar ranks in the Khutzeymateen. New BHUs will be developed from the vegetation mapping and classification process and ranked according to food availability by season. Collared bear use ranks by BHU will be compared to food ranks to test the hypothesis that there is no relation between movement and food abundance.

Population Data

Population data for grizzly bears is extremely difficult to gather. There are no accurate means of census in forested areas (short of total capture and marking), sample sizes are usually small (population research is extremely expensive), and studies are most often of short duration relative to the life span of the animal (25 years). Recent mark-recapture techniques applied successfully to northern grizzly populations (e.g., Miller et al. 1987) are not feasible in the Khutzeymateen. The Khutzeymateen study is not long enough or funded enough to capture and mark all bears.

Instead, the grizzly bear population density in the Khutzeymateen will be estimated by recording all occurrences of known and unknown bears, and bounding the study area on the basis of movements of radio-collared animals. These data, in addition to visual observations of recognizable individuals, will at least provide a minimum estimate. Wherever possible, bears will be identified as residents (present in all seasons within the study area) or transients (present in only some seasons). Monitoring collared bears in the breeding season will be concentrated on lone adult females and adult males to determine if they mate with unknown individuals.

Data on population characteristics including minimum age of reproduction, survivorship, breeding interval, litter size, and dispersal rates will be obtained opportunistically. The environment, duration, and funding level of the study preclude focusing efforts on these data.

ANALYTICAL METHODS

Habitat Evaluation

Grizzly bear habitats in the Khutzeymateen will be evaluated on both a *type* and a *patch* basis. Each habitat polygon will have two values; a value for that type of habitat for various activities, and a patch value based on where it occurs in the watershed. Location (and size) can confound type values. For example, a floodplain BHU used in some seasons for feeding on berries may be beside a spawning channel. That polygon's value is higher than another of the same type away from the river. Similarly, a forested habitat polygon that is located near an important feeding area (e.g., the estuary) may normally have low feeding and bedding value; however, its proximity to the important unit elevates its *patch* value.

Values will be derived from three separate processes:

1. habitat type use/availability analysis (collared bears and incidental data),

2. habitat type ranking assigned on the basis of food and cover values, and

3. examination of use by patch (juxtaposition and interspersion analyses).

The methods for processes one and two above are described by Hamilton (1987) and will be adapted to the Khutzeymateen. New techniques, relying heavily on a Geographic Information System (GIS), will be used to address the third component of the evaluation or the "spatial relationships" of the study

Table 3. Seasonal use ranks for Bear Habitat Units in the Kimsquit River, B.C

Bear Habitat Unit	Season							
	1	2	3	4	5	6	7	8
Non-vegetated	L	L	L	L	M	M	L	L
Estuary	H	H	H	H	M	M	M	L
Avalanche chute	L	L	H	M	L	L	L	L
Mountain hemlock	H	L	H	M	L	L	L	H
Subalpine parkland	L	L	L	M	L	L	L	L
Dry shore pine	L	L	L	L	L	L	L	L
Sedge fens	H	H	M	M	L	L	L	L
Skunk cabbage swamps	M	H	H	M	M	M	H	L
Sidehill and bench climax and old-growth forests	L	L	M	M	L	L	M	L
Submesic forests	L	L	L	M	L	L	L	L
Floodplain climax and old-growth forests	L	H	M	H	H	H	M	L
Floodplain seral forests	L	M	M	H	H	H	M	L
Floodplain seral non-forest	L	L	L	L	H	H	L	L
Logged	L	L	L	M	L	L	L	L

H=high, M=medium, L=low habitat use

animals to their habitat. GIS are particularly useful for species like grizzly bears that utilize a wide variety of habitats within extensive home ranges.

Based on research conducted elsewhere in coastal British Columbia (Lloyd 1979, Hamilton 1987) and information from southeastern Alaska (Schoen and Beier 1986), grizzly bears using the Khutzeymateen are expected to have home ranges of 50 - 400 km^2. High levels of diversity within home ranges are expected in elevations, topography, terrain, plant communities, and soils. Although GIS are well suited to examine this variation among habitat patches (beta diversity) (Marcot 1986), perhaps their greatest utility is their ability to analyze diversity at the gamma or regional landscape scale (Harris and Kangas 1988). Harris and Kangas (1988) suggest that grizzly bears seem to be "creatures of the landscape rather than of any specific habitat type"; a suggestion only partly supported by data collected in the Kimsquit (Hamilton 1987). GIS-based analyses using the Khutzeymateen data will help investigate the question of patch and type-specific selection versus the landscape concept.

The proposed thematic inputs to the GIS are summarized in Table 4. The various themes consist of two parts; a "map" of points, lines, or polygons and a wide variety of attribute data files linked to these features. Analyses proposed (Table 5) are sequential; for example, habitat type evaluation will not be complete until Group 1 overlay and subsequent use/availability analyses are completed.

Impact Assessment

It is difficult to assess responses of wildlife populations to habitat changes because of problems in data collection and a general lack of understanding of species/habitat relationships. The links between wildlife habitat and population productivity are poorly understood. Ruggiero et al. (1988) define ecological dependency as "the relationship between a population and the environment(s) required for its persistence." They further suggest that "populations will persist only if: 1) there are sufficient kinds, amounts, and patterns of environments available to meet the biological needs of individuals within populations; and, 2) these environments provide sufficient resources to sustain populations as environmental, genetic and demographic conditions fluctuate over time." This is precisely the challenge for the Khutzeymateen research: if logging development occurs, will the habitat base in the future be sufficient to meet individual and population requirements?

Accurate prediction of impacts of development on a grizzly bear population would require experimentation in unprecedented spatial and temporal scales (see Ruggerio et al. 1988). Instead, models of population impact will have to be developed that parallel the Cumulative Effects Analysis (CEA) procedure described by Weaver et al. (1986). Although models have been developed that attempt to quantify the links between population and habitat characteristics for a number of wildlife species (e.g., Fagen 1988), no models have yet been verified and/or validated. The CEA process developed for grizzly bears (Weaver et al. 1986) is being used to assist with major land use decisions in the conterminous United States; however, it remains untested.

Although the ability of GIS to analyze spatial information has been demonstrated and continues to evolve, few studies have made an attempt to link the spatial information with temporal simulations, i.e., environmental changes through time (Lancia et al. 1986). Impact assessments using conventional tools such as Habitat Suitability or Pattern Recognition models (Cooperrider 1986) focus on the quality and quantity of habitat affected but do so only into the immediate future, e.g., Habitat Evaluation Procedures (Urich and Graham 1983). The spatial and temporal elements of habitat/species relationships interact in complex ways (Ruggerio et al. 1988) and this complexity must be addressed in evaluating the forest development scenarios on grizzly bears in the Khutzeymateen. Adequate assessment of the impacts of development will

Table 4. Proposed thematic inputs for Khutzeymateen GIS

Component	Scale	Input Type	Attribute File
Intensive Study Area - Operable			
Planimetric & Cadastral	1:10 000	TRIM	Map position data Map representation data
DTM	1:10 000	TRIM	Digital terrain model
Terrain	1:10 000	polygon	Terrain units (stability, etc.)
Forest Cover	1:10 000	polygon	Species,stocking,height,age,site class
Fisheries	1:10 000	line	Stream Reach Class
Habitat	1:10 000	polygon	Habitat units (site association, seral stage, silviculture group)
Bear Location	1:10 000	point	UTM coordinates
Home Range	1:10 000	polygon	individual, composite
Intensive Study Area - Operable and Inoperable			
Terrain	1:50 000	polygon	Terrain units (watershed only)
Habitat	1:20 000	polygon	Habitat units (watershed only)
Home Range	1:20 000	polygon	individual, composite

Table 5. GIS analyses and expected products

Inputs	Analysis Type	Expected Products
Group 1. Grizzly Bear		
Bear Locations & Fisheries	Distance Measurement	distance to salmon
Bear Locations & Habitat	Grid Cell Analyses & Point Overlay	verification of habitat assignment, diversity index, interspersion, juxtaposition
Bear Locations & DTM	Point Overlay	tabular summaries of locations by elevation, slope, and aspect classes
Bear Home Ranges & Habitat & DTM	Polygon Overlay	tabular summaries of habitat availability & within individual and composite home ranges
Bear Home Ranges & LANDSAT/DTM	Polygon Overlay	tabular summaries of generalized habitat units within the composite home ranges of all bears using the Khutzeymateen
Group 2. Forestry		
Forest Cover	Algorithm	Net down (non-commercial types removed)
Forest Cover & DTM	Polygon Overlay	Net down (areas too steep removed)
Forest Cover & Terrain	Polygon Overlay	Net down (areas too unstable removed)
Forest Cover & Fisheries	Line Buffering	Net down (areas for fisheries habitat removed)
Forest Cover & Habitat	Polygon Overlay	Net down (areas of high bear value removed)
Group 3. Land Use Scenarios - First Pass		
Road Networks & Habitat	Line Buffering	Habitat reduction (corridor habitat alienated)
Cutblocks & silviculture group	Polygon Overlay	Habitat reduction, summary of area by Habitat
Group 4. Land Use Scenarios - Future Simulation		
Habitat (original) & Cutblocks (regen)	Algorithm	Area summary by type at 5 year intervals post logging

depend not only on accurate projection of the spatial arrangement of habitat (e.g., amount, patch size, diversity) immediately after logging, but also on a reliable model of habitat supply into the future. For a species that lives for ≥25 years, accurate determination of the long-term impacts of habitat loss, alteration, or alienation is essential.

Although the specific procedures to conduct the impact assessment are not finalized, the general steps proposed are as follows:

Step 1: Assess the values of the current habitats (suitability) in the study area.

Step 2: Assess the values in the study area by modelling the impacts of each of the proposed forest development scenarios without including successional change after logging.

Step 3: Assess the values in the study area through time by modelling the full impacts of each of the proposed forest development scenarios (including a post logging secondary succession, comprehensive patch and type impact assessments, and an assessment of the impacts of proposed silviculture, road construction, and future logging plans).

Step 1 provides a benchmark evaluation against which the forest development scenarios will be assessed. Step 2 provides a first approximation of development impacts that may modify which scenarios should be assessed in Step 3. Questions such as potential forest fragmentation (Franklin and Forman 1987) and loss of habitat diversity will also be addressed. Table 5 outlines some of the analyses proposed. Specifically, the impact assessment process will rely on four types of information: testing specific hypotheses, analysis of less rigorous data (e.g., visual observations of grizzly bears), the application of relevant information collected elsewhere in British Columbia, and best professional judgement. Although outside the grizzly bear study mandate, an assessment of the potential impacts of development in context of the management objectives for grizzly bears and timber in north coastal B.C. will be conducted by the Project Steering Committee.

More specific procedures and assumptions will be detailed in subsequent annual working plans and progress reports.

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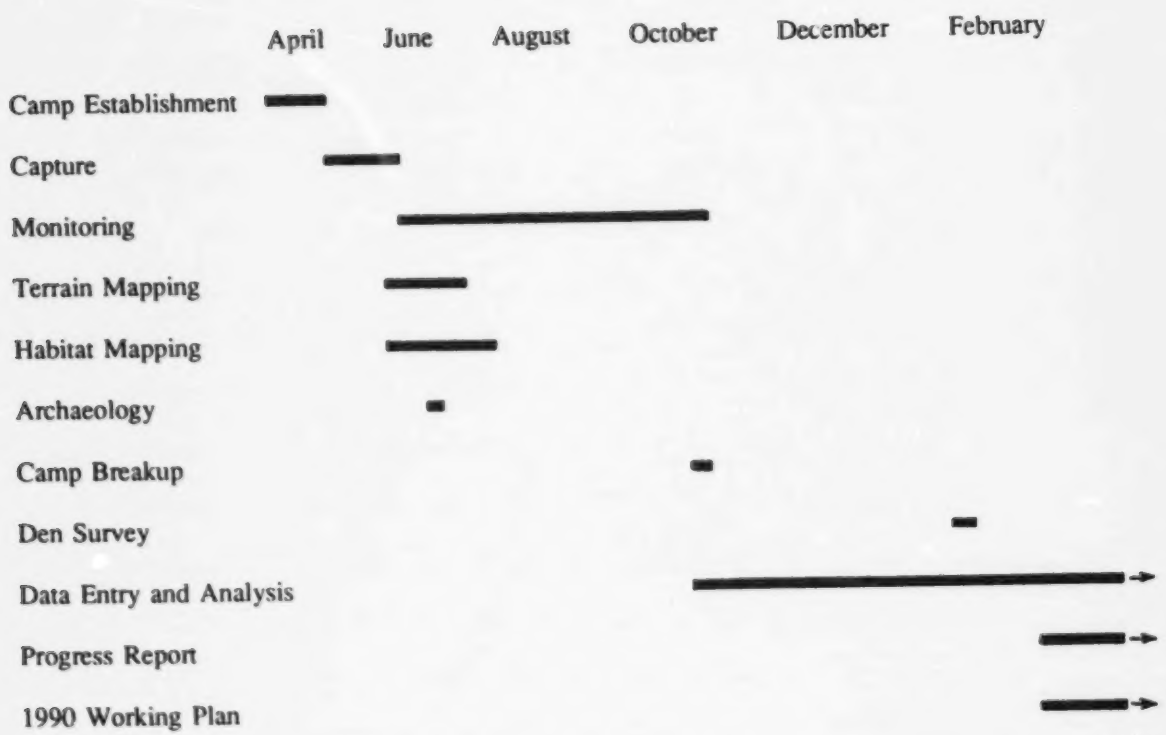
Appendix A



Appendix B

The following documentation is planned for the study:

1) project working plan

2) annual progress reports

3) annual working plans

4) publications in technical/professional journals as appropriate

5) Khutzeymateen Grizzly Study Newsletter - issued monthly to update progress

6) final study completion document - input to the land use decision process.

All project documents will be reviewed by the Management Coordinating Committee and the Research Advisory Committee.

Appendix C

BEAR CAPTURE DATA SHEET--1989

BEARS NAME: _____

BEAR #: _____ SPECIES: | GB | BB| DAY _____ MON _____ YEAR _____

SEX: | male | female | REPRO STATUS: | subadult | adult |

NUMBER OF YOUNG: _____ AGE OF YOUNG: | cubs | ylngs | 2 yrs | 3 yrs

TATTOO NUMBER: _____ TATTOO LOCATION: | lower lip | groin |

RADIO COLLAR:

FREQUENCY: _____

PULSE RATE: _____

MODEL TYPE:_____

SERIAL #: _____

COLLAR LENGTH:_____

COLOUR CODING:

| rd | og | yl | gn | lbl | bei |

| gry | whi | red-whi | gre-whi |

TRAPPING:

TYPE OF CAPTURE: | trail | cubby

BAIT USED: | yes | no |

FOOT SNARED: | rf | lf | rh | lh

SNARE POSITION: | wrist | arm |

CONDITION OF SNARED FOOT: _____

_____

_____

_____

DRUGGING PROCEDURE:

DOSE	DRUG	VOL (cc)	TIME	HIT OR MISS	RANGE	HIT SITE
1	M99- M50	_____	____:____	HIT-MISS	_____m	_____
2	M99- M50	_____	____:____	HIT-MISS	_____m	_____
3	M99- M50	_____	____:____	HIT-MISS	_____m	_____
4	M99- M50	_____	____:____	HIT-MISS	_____m	_____
5	M99- M50	_____	____:____	HIT-MISS	_____m	_____

TRAP TRANSMITTER TIME DATA:

CURRENT TIME: |____:____| TRANSMITTER CLOCK TIME: |____:____| AM | PM |

TIME BEAR CAPTURED: |____:____| NO HOUR BEARS IN SNARE: |____:____|

BEHAVIOURAL AND PHYSIOLOGICAL MEASUREMENTS:

TIME	BEHAVIOUR	RESP RATE (RRPM)	HEART (PPM)	RECTAL TEMP	AMBIENT TEMP BLACK	AMBIENT TEMP SILVER
____:____						
____:____						
____:____						
____:____						
____:____						
____:____						
____:____						
____:____						
____:____						
____:____						
____:____						
____:____						
____:____						
____:____						
____:____						

MEASUREMENTS OF PHYSICAL CHARACTERISTICS AND CONDITION

BODY WEIGHT _____lb/kg

ZYGO WIDTH _____cm

SKULL LENGTH _____cm

TOTAL LENGTH _____cm

NECK GIRTH _____cm

HEART GIRTH _____cm

ABDOMINAL GIRTH _____cm

CANINE LENGTH _____cm

TAIL LENGTH _____cm CANINE WIDTH _____cm

SHOULDER HT _____cm HIND FOOT: L_____ W_____cm

BACULUM LENGTH _____cm FRONT FOOT: L_____ W_____cm

NIPPLE LENGTH _____cm

TOOTH WEAR: | min | mod | heavy |

VULVA CONDITION: | normal | slightly swollen | swollen |

EVIDENCE OF NURSING: | rubbed | lactating | normal |

EXTERNAL PARASITES: | yes | no |

PELAGE COLOR: _____

_____

PELAGE CONDITION: _____

_____

BIOLOGICAL SAMPLES

TOOTH EXTRACTED: | LLPM1 | LRPM1 | ULPM1 | URPM1 |

HAIR SAMPLE: | head | dorsal | ventral |

HAIR SAMPLE COLLECTION #: _____

EXTERNAL PARASITE SAMPLE COLLECTION #: _____

FAECES SAMPLE COLLECTION #:_____

BLOOD SAMPLES:

RED: _____ HEMATOCRIT: _____

GREY: _____ RED BLOOD CELL COUNT: _____

PURPLE: _____ WHITE BLOOD CELL COUNT: _____

VAGINAL SMEARS: | yes | no | SMEAR SLIDE #:_____

COMMENTS: _____

_____

_____

_____

Appendix D

SITE INVESTIGATION FORM

FORM NO: |___|___|___|

SITE CHARACTERISTICS

SITE NO: |___|___|___| DATE: D D M M Y Y |___|___|___|___|___|___|

SURVEYORS: |___|___| |___|___| |___|___|

X-COORD |___|___|___|___|___| Y-COORD |___|___|___|___|___| PLOT SIZE (m): |___|___|___|___| ELEVATION (m): |___|___|___|___| SLOPE: |___|___|___| ASPECT: |___|___|___|

ELEVATION (m): |___|___|___| SLOPE: |___|___|___| ASPECT: |___|___|___|

HABITAT CHARACTERISITCS:

TYPE: |___|___|___|___|___|___| POLYGON: |___|___|___|___| STRAT %: TREE |___|___| B2 |___|___| B2 |___|___| C |___|___| D |___|___|

COVER VALUE: N |___|___| E |___|___| S |___|___| W |___|___|

TYPE: 1. SHRUBS 2. DEBRIS 3. TOPOGRAPHY 4. TREES N E S W |___|___|___|___|

SOIL TYPE: |___|___|___|

TIME OF LOCATION: |___|___|___|___|

ACTIVITY CHARACTERISTICS:

ACTIVITY (circle 6 max):
1. BED
2. FEED
3. MARK TREE
4. MARK TRAIL
5. TRAVEL
6. OTHER_____
_____
SPECIFY
* = PRIMARY ACTIVITY WHERE COVER WAS MEASURED

SEASON (circle 1 max):
1. LEAF FLUSH
2. CHUTE GREENUP
3. BERRY PRODUCTION
4. BERRY TO SALMON
5. BERRY & SALMON
6. SALMON
7. POST SALMON

WX AT USE (circle 1 max):
1. UNKNOWN
2. RAIN
3. INTERMITTANT RAIN
4. OVERCAST
5. CLOUDY
6. FEW CLOUDS
7. CAVU
8. OTHER_____
SPECIFY

USE/RELOCATION DATE: D D M M Y Y |___|___|___|___|___|___|

SIGN AGE: |___|___| DAYS

BEAR NO: |___|___| RELOC SHEET NO: |___|___|___|

OTHER BEARS: 1 |___|___| 2 |___|___| 3 |___|___| 4 |___|___|

TELEMETRY RELIABILITY: (circle 1 max)
1. POSITIVE
2. PROBABLE
3. POSSIBLE
4. DOUBTFUL

VERIFICATION: (circle 7 max)
1. HAIR
2. TRACKS
3. TELEMETRY
4. VISUAL
5. AGE
6. SCAT
7. DISTURBANCE

BED MEASUREMENTS: LENGTH |___|___|___| WIDTH |___|___|___| DEPTH |___|___| BED TREE |___|___|___| D B H |___|___|___|

MARK TRAIL: LENGTH: |___|___| IMPRESSIONS |___|___|

STATUS (circle 1 max)
1. PERMANENT
2. OCCASSIONAL

MARK TREE: SPECIES |___|___| D B H |___|___| HT MARKED |___|___|___| AGE |___|___|___|

FOOD SPECIES (order of use): 1 |___| 2 |___| 3 |___| 4 |___| 5 |___|

DISTANCE MEASURES:

TO OPENING (M) |___|___|___| HABITAT TYPE |___|___|___|___|___| TO COVER (M) |___|___|___| TYPE OF COVER |___|___|___|___|___|___| COVER VALUE N |___|___| E |___|___| S |___|___| W |___|___|

TO SALMON (M) |___|___|___|

SALMON AVAILABILITY (circle 1 max)
1. NONE
2. LOW
3. MEDIUM
4. HIGH

SALMON ABUNDANCE (circle 1 max)
1. NONE
2. LOW
3. MEDIUM
4. HIGH

COVER TYPE N |___| E |___| S |___| W |___|

SAMPLES COLLECTED

FOOD SAMPLES:

SITE NO	FOOD

SCATS:

SITE NO	REF NO

PHOTOGRAPHS:

SITE NO	REF NO

SITE DIAGRAM:

COMMENTS:

Appendix E

MARK TREE DATA FORM

TREE NO: |___|___|___| SITE NO: |___|___|___| POLYGON NO: |___|___|___|

TELEMETRY LOCATION NO: |___|___|___| PERSONNEL: 1. _____
2. _____
3. _____
4. _____

SITE INVESTIGATION FORM NO:|___|___|___|

DATE: |___|___| DD |___|___| MM |___|___| YY

AIR PHOTO NO: |___|___|___| - |___|___|___|

UTM: |___|___|___|___|___|___|___| N |___|___|___|___|___|___| E

CHARACTERISTICS OF MARK TRAIL

	A	B	C	D	E	F
SITE-TREE						
TREE SPECIES						
MOST RECENT USE						
VERIFICATION						
TREE TYPE						
DBH (CM)						
TREE:						
AGE						
BORE HEIGHT (CM)						
CORRECTED AGE						
SCAR:						
AGE THROUGH						
BORE HEIGHT (CM)						
CORRECTED AGE						
MARK/SCAR ASPECT						
BEARING-NEAREST TRAIL						
DISTANCE-NEAREST TRAIL						
TRAIL ORIENTATION (<=180)						
FOOD						
DISTANCE TO						
TYPE						
SCAR						
BOTTOM HEIGHT						
MAX LENGTH						
MAX WIDTH						
MARK						
MAX HEIGHT						
MIN HEIGHT						
SCUFF AREA						
SCRATCHING						
RUBBING						
BITING						
PITCH						
MARK TRAIL						
LENGTH						

NO FOOT PADS						
PADDING DISTANCE						

CODES FOR CHARACTERISTICS OF MARKING

VERIFICATION OF MARK TREE:
CIRCLE 7 MAX)
1) HAIR
2) TRACKS
3) TELEMETRY
4) VISUAL
5) AGE
6) SCAT
7) DISTURB

MOST RECENT USE:
1. THIS YEARS
2. LAST YEARS
3. UNKNOWN

TREE TYPE:
(CIRCLE 1 MAX)
1. FOOD/TRAVEL
2. TRAVEL
3. FOOD
4. BATHTUB
5. BED

CODES FOR-- SCUFF AREA
SCRATCHING
RUBBING
BITING
PITCH:
1. HIGH
2. MEDIUM
3. LOW
4. NONE

PHOTO/SLIDE REF NO:

SITE CHARACTERISTICS:

HABITAT TYPE:

DISTANCE TO ECOTONE: M

	N	E	S	W
COVER:				

	N	E	S	W
COVER TYPE:				

INVENTORY OF TREES ASSOCIATED WITH MARK TREE:

TREE NO	SPP	DBH	AGE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

COMMENTS:

DIAGRAM:

Wildlife Working Reports should not be cited because of the preliminary nature of the data they contain

WR-1 Progress report - coastal grizzly research project: Year 1. A.N. Hamilton. First printed October 1984, revised October 1986. 32pp. (Also printed as WHR-9).

WR-2 Progress report - year 2 - 1983, working plan - year 3 - 1984. Coastal grizzly research project. A.N. Hamilton and W.R. Archibald. First printed October 1984, revised October 1986. 32pp. (Also printed as WHR-10).

WR-3 Telemetry: comments and suggestions from the coastal grizzly project 1983. A.E. Derocher. October 1984. (Also printed as WHR-11).

WR-4 Habitat types of the Kimsquit River estuary. C. Clement. October 1984. 27pp. (Also printed as WHR-12).

WR-5 Biogeoclimatic units and ecosystem associations of the Kimsquit drainage. C. Clement. October 1984. 93pp. (Also printed as WHR-13).

WR-6 Kechika Enhancement Project of northeastern B.C.: wolf/ungulate management. 1983-84 annual report. J.P. Elliott. October 1984. 25pp.

WR-7 Muskwa Project working plan. J.P. Elliott. December 1984. 32pp.

WR-8 Muskwa Wolf Management Project of northeastern B.C. 1983-84 annual report. J.P. Elliott. December 1984. 23pp.

WR-9 Kechika Enhancement Project of northeastern B.C.. Revised working plan for 1984-87. J.P. Elliott. December 1984. 12pp.

WR-10 Home on the range: how to cook an urban goose. W.T. Munro, R.T. Sterling, and M.D. Noble. February 1985. 19pp.

WR-11 Effect of wolf control on black-tailed deer in the Nimpkish Valley on Vancouver Island. Progress report -1983 August 31 to 1984 August 31. K. Atkinson and D. Janz. March 1985. 22pp.

WR-12 1983 southeastern Skeena regional moose abundance and composition survey. B. van Drimmelen. June 1985. 47pp.

WR-13 Kechika Enhancement Project of northeastern B.C.: wolf/ungulate management. 1984-85 annual report. J.P. Elliott. September 1985. 28pp.

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WR-15 Caribou habitat use on the Level Mountain and Horseranch ranges, British Columbia. M.A. Fenger, D.S. Eastman, C.J. Clement, and R.E. Page. 1986. 41pp + 4 maps. (Also printed as Surveys and Resource Mapping Branch Working Report WR-8).

WR-16 Working plan - coastal grizzly research project. W.R. Archibald and A.N. Hamilton. October 1985. 27pp. (Also printed as WHR-21).

WR-17 Progress report - year 3 - 1984, working plan - year 4 - 1985. Coastal grizzly research project. W.R. Archibald, A.N. Hamilton, and E. Lofroth. October 1985. 65pp. (Also printed as WHR-22).

WR-18 Morice biophysical study, 93L/SW. B. Fuhr, M. Fenger, L. Lacelle, R. Marsh, and M. Rafiq. March 1986. 63pp + 9 maps.

WR-19 Effect of wolf control on black-tailed deer in the Nimpkish Valley on Vancouver Island. Progress report - 1984 August 31 to 1985 August 31. K. Atkinson and D.W. Janz. March 1986. 27pp.

WR-20 Kechika Enhancement Project of northeastern B.C.: wolf/ungulate management. 1985-86 annual report. J.P. Elliott. December 1986. 17pp.

WR-21 Muskwa Wolf Management Project of northeastern B.C. 1985-86 annual report. J.P. Elliott. December 1986. 15pp.

WR-22 Progress report - year 4 - 1985, working plan - year 5 - 1986. Coastal grizzly research project. A.N. Hamilton, W.R. Archibald, and E. Lofroth. February 1987. 90pp. (Also printed as WHR-26).

WR-23 Critical habitat of caribou (*Rangifer tarandus caribou*) in the mountains of southern British Columbia. K. Simpson, K. Hebert, and G.P. Woods. February 1987. 13pp.

Continued on back cover

Continued from inside back cover

WR-24 Impacts of a hydro-electric reservoir on populations of caribou and grizzly bear in southern British Columbia. K. Simpson. February 1987. 40pp.

WR-25 The effects of snowmobiling on winter range use by mountain caribou. K. Simpson. February 1987. 15pp.

WR-26 Quesnel Highlands wolf control project. D. Hebert. January 1987. 10pp.

WR-27 Muskwa Wolf Management Project of northeastern B.C. 1986-87 annual report. J.P. Elliott. April 1987. 20pp.

WR-28 Vancouver Island wolf control project. Year 1 progress report. D. Janz. July 1987.

WR-29 Habitat survey of the Mackenzie Heritage Trail corridor. V. Hignett. June 1987. 21pp + 5 maps.

WR-30 A proposal to manage coyote and cougar populations of the Junction Wildlife Management Area. D. Hebert. September 1987. 11pp.

WR-31 Wildlife habitat suitability of the Mackenzie Heritage Trail corridor. V. Hignett. May 1988. 16pp + 6 maps.

WR-32 Research priorities for furbearers in British Columbia. D. Blood. June 1988. 49pp.

WR-33 Electrically triggered drop net to capture wild sheep. J.W. Hirsch. 1988. 18pp.

WR-34 A lynx management strategy for British Columbia. D.F. Hatler. July 1988. 121pp.

WR-35 Causes of bighorn sheep mortality and dieoffs - literature review. H.M. Schwantje. April 1988. 54pp.

WR-36 Explanatory legend for vegetation maps of the Kamloops Lake bio-physical study area. E.C. Lea. December 1988. 78pp.

WR-37 Bio-physical habitat units and interpretations for moose use of the upper Cariboo River Wildlife Management Area. E.C. Lea, T. Vold Young, M. Beets, D. Blower, J. Youds, A. Roberts. December 1988. 24pp.

WR-38 Grizzly bear habitat of the Flathead River area: expanded legend. E.C. Lea, B.L. Fuhr, and L.E.H. Lacelle. December 1988. 24pp.

WR-39 Managing habitat through guidelines: How far can you go? M. Fenger and V. Stevens, eds. February 1989.

WR-40 Wolf-prey dynamics. Proceedings of a symposium sponsored by B.C. Ministry of Environment, Wildlife Branch, Faculty of Forestry, University of British Columbia and the Northwest Wildlife Preservation Society. February 1989.

WR-41 Caribou research and management in B.C.: proceedings of a workshop. R.Page, ed. November 1988. (Also printed as WHR-27)

WR-42 Trapping in British Columbia - a survey. R. Reid. January 1989.

WR-43 Biophysical habitat units of the Lower Halfway study area: expanded legend. E.C. Lea and L.E.H. Lacelle. December 1989. 33pp.

WR-44 Long range habitat planning: proceedings. M. Fenger and V. Stevens, eds. March 1990. 49pp.

WR-45 Biophysical habitat units of the Mosley Creek study area: expanded legend and interpretations. E.C. Lea and R.C. Kowall. March 1990.

WR-46 Habitat Management Section. Annual General Meeting. Yellowpoint Lodge - 1989 April 25-27. (In prep.)

WR-47 Working plan — Khutzeymateen Valley grizzly bear study. A.N. Hamilton and J.A. Nagy. September 1990. 35pp. (Also printed as WHR-28).

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